CO-EXTRA

GM and non-GM supply chains: their CO-EXistence and TRAceability

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PU Public	
PP Restricted to other programme participants (including the Commission Services)	
RE Restricted to a group specified by the consortium (including the Commission Services)	**X**
CO Confidential, only for members of the consortium (including the Commission Services)	

Cost and benefit categories for ensuring co-existence and traceability

Participants:

FOI
FIBL
HOGENT
FW
SGGW/WAU
INTA
UNIBRASIL

Content

1 Introduction

This deliverable describes the template to be used for the presentation of costs and benefit categories to ensure coexistence in food and feed supply chains.

The template has a generic structure and will be used for all supply chains to be studied in task 3.2 and contains a gross list of cost and benefits items relevant for ensuring coexistence in food and feed supply chains. Not all costs and benefit items will be relevant for all supply chains, and the overall template will be adopted to the individual supply chains.

In table 1 an overview of partners and commodities are presented.

Crop	Soybean	Maize	Rape seed	Wheat	Sugar beat
Argentina	X				
Belgium	X				
Brazil					
Denmark	X	X		X	X
France	X		X		
Germany				X	X
Poland	X		X		
Spain		X			
Switzerland		X	X		
England					X

Table 1. List of analyzed supply chains and regions.

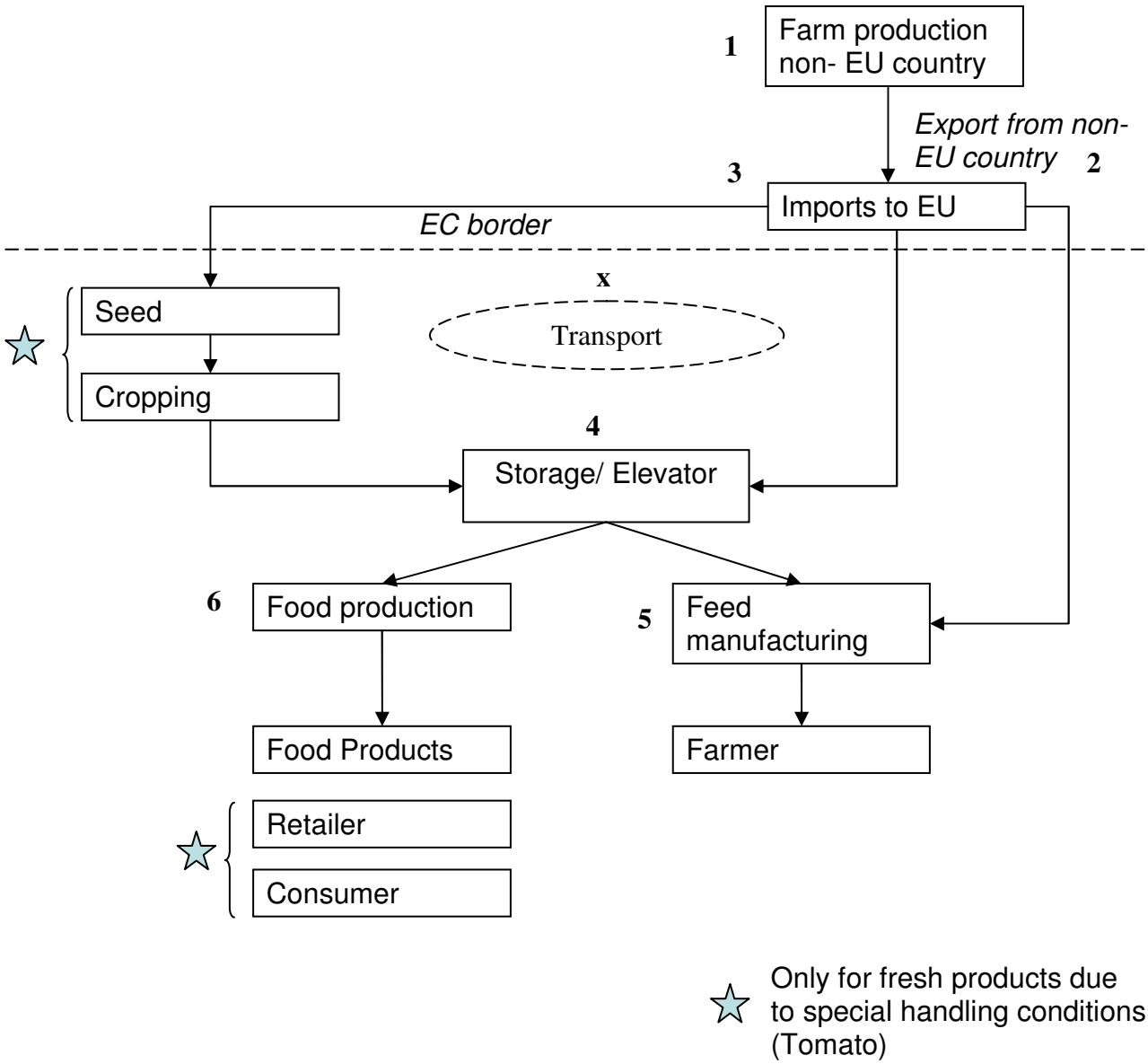
2 Structure of reporting

The presentation for each supply chain should have the following headlines;

1. Commodity and country
2. Company description
3. Chosen strategy for handling coexistence
4. Costs specified by activity
5. Possible benefits
6. Conclusion

3 Overview of cost categories in the chain

In the figure presented below it should be possible to identify the costs items for all the commodities investigated. Each number on the figure represents a cost category that should be described in detail. (See annex 1)



4 Template for reporting

4.1 State commodity and country (one for each stakeholder)

In order to insure the maximum comparability of the supply chains it is important that every commodity investigated has a precise definition.

4.2 Company description

In order to get an overview of the reliability of the studies presented the number of interviewed companies for each commodity should be mentioned. This number should be related to the total number of companies in the country involved with the process investigated. Some companies will prefer to stay anonymous in the survey. In that case the market share of the company is vital. The following data should be presented;

Company profile (short description, shareholders etc.)
Annual turnover
Annual turnover, strictly related to commodity (if possible to obtain)
Type op products 1-n (in investigated factory)
Production of X-n (stated in tons)
Market share for products
Amount of import and export
Age of processing equipment (storage facilities, machinery etc.)

4.3 Chosen strategy for handling Co-existence

In this section the chosen strategy for the company or companies should be presented.
In figure 1 and overview of the strategies are presented.

GMO-segregation strategies

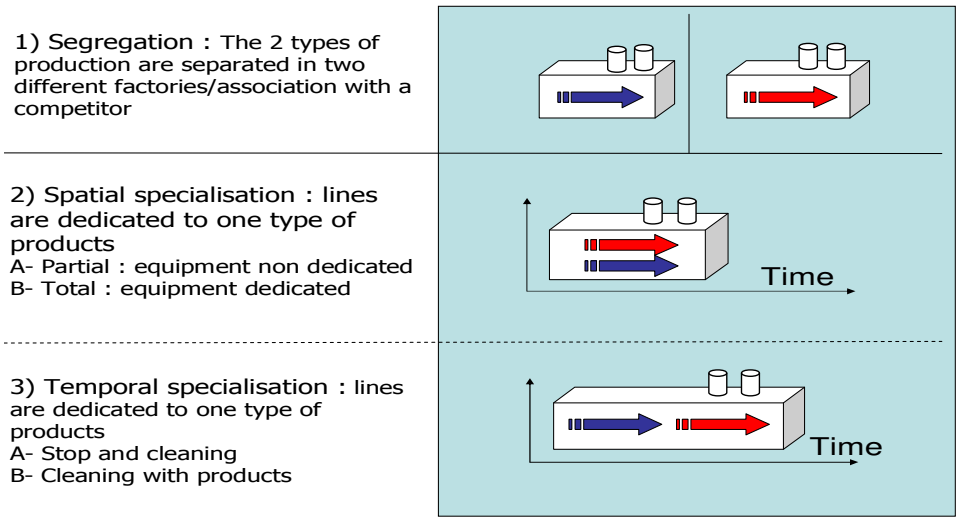


Figure 1: GMO-segregation strategies

To describe the company strategy the following parameters should be included.

- Present situation regarding percentage GMO / non-GMO (e.g. 10 % non-GM soymeal)
- Strategy chosen based on status quo (the current situation, see figure 1)
- The tendency in the market towards GMO / non-GMO percentage
- The company's expectations towards the future related to GMO /non-GMO percentage (Describe what their expectations are based on)
- If possible describe how the company's deals with an organic production line (inspiration to the extra costs of separation for those commodities with no practical experience of GMO/nonGMO segregation)
- Describe why this strategy was chosen in relation to costs.
- What would make them shift their current strategy and why?

4.4 GM / non-GM share

Describe how the strategy and cost changes with the non-GM / GM market demand percentage using the table below and information on strategies presented in figure 1. It is assumed that a company chooses a product mix (GM / non-GM) based on the 3 hypothetical marked demands presented in table 1. It may be the case that a company chooses only one strategy regardless of the 3 hypothetical marked demands. In the first column the **current** situation should be presented with the actual percentages of segregation (this could for instance be zero GM for specific chain). The **strategy** chosen is described using the numbers (1,2 or 3) indicating different strategies from figure 1 with short comments. For each strategy the costs are described in the text and the main costs related to the chosen strategy are presented in the table under "**Highest costs of segregation**". The data should be filled out for each of the scenarios with 90%, 50% and 10% non-GMO. The table is presented to give a comparable overview of the supply chains.

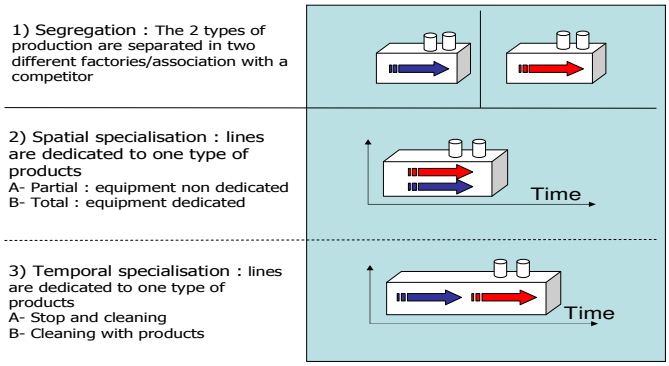
Table 1

Situation/ Change	**Current**	**Hypothetical**	**Hypothetical**	**Hypothetical**
GMO pressure[1]	Status quo (x% GM / y% non-GM)	90% non-GMO	50% non-GMO	10% non-GMO
Strategy	e.g. 2	e.g. 2 or no production of non GMO	e.g. 1	e.g. 2 (or no production of non GMO
Highest extra costs for GM segregation	e.g. Cleaning	e.g. Cleaning / transport	e.g For instance Testing	e.g. Storage / cleaning

[1] GMO pressure is the market demand for GMO/non-GMO

4.5 Extra cost specified by activity

In the following paragraph the specific additional costs for segregation and traceability related to each step in the supply chain is presented. The categories that are relevant to each specific commodity can be found in annex 1. The cost of segregation depends on the chosen strategy and costs as well as benefits related to each strategy should be presented when possible.



1

Farm Production non-EU

Harvest (the machine used for harvesting has a temporal specialization too)
Monitoring
Raw materials (seed)
Segregation
Storage (silo bags)
Sowing
Weed Control

2

Exports from non-EU

Analysis Test
Uploading
Taxes

3

Imports into EU

Administration/Monitoring
Analysis
Certification
Flushing/cleaning
Monitoring
Operation of quality system
Raw materials
Segregation
Storage/Elevator

5
Elevator/Storage
Analysis
Extra cost to transport (to new storage)
Flushing/cleaning
Loss in flexibility
Monitoring
Operation of quality systems
Personnel
Segregation
Storage/elevator
Costs of separating in two different plants

6
Feed manufacturing
Analysis
Flushing / cleaning
Labelling
Loss of flexibility
Operation of quality systems
Personnel
Raw materials
Segregation
Costs of separating in two different plants / single production line etc.

7
Food production
Analysis
Flushing / cleaning
Labelling
Loss of flexibility
Operation of quality systems (Updating etc.)
Personnel
Raw materials
Segregation
Costs of separating in two different plants / single production line etc.

X
Transport (between all actors of the chain)
Administration/Registration
Cleaning of transport equipment
Loss in flexibility
Monitoring
Operation of quality systems
Personnel

4.6 Benefits (possible)

A well established GM/nonGM segregation and traceability system will give possibility to gain a number of benefits. Part of these benefits will be of a more qualitative nature and will therefore be difficult to quantify in direct economic terms. It is however important to discuss the possible benefits with the companies and describe which benefits they find the most important.

Examples of benefits in this context can be:

- lower costs of documentation
- lower transaction costs
- lower operational costs
- optimal utilisation of production capacity
- utilise the market opportunities for both GM and nonGM crops as input
- utilise GM crops with enhanced processing properties
- utilise future possibilities of GM crops with enhanced end user properties
- possibility to serve both GM and non-GM market segments
- comply with retailers demands
- gain consumers confidence

4.7 Conclusion

In this paragraph the main results from the chain shall be presented. The conditions for drawing the conclusions should be clearly stated and main costs and benefits should be highlighted.

Annex 1: Definitions of extra costs associated with coexistence

In the following paragraph is given a definition to some predefined extra costs categories that are associated with coexistence.

The data we need to obtain are strictly related to the **extra cost and benefits** that are associated with the coexistence between GMO and non-GMO when existing food and feed regulations have been complied with (eg. Regulations 852/2004 and 183/2005). All costs and benefits should be stated in Euros and all weights should be presented in metric tons. For any fixed costs a depreciation period should be stated.

Administration/Registration: to demonstrate the segregation of batches a clear and reliable system of registrations of all operations needs to be introduced. These registrations might be carried out manually or automatically. Obviously the manual registration, which might be more the case for smaller companies, will be in need of more time and therefore will be more costly. Nevertheless, a well-documented and automated system requires investments in hard- and software.

Analysis: the cost for analysis might depend on the type of analysis (DNA or protein based), the required speed to obtain a result, the ingredient (more approved GM maize varieties than GM soy, therefore extra cost of analysis for samples containing GM maize) and the number of GM ingredients in the sample (GMO labelling is ingredient-based).

Audit: an audit is required to check the compliance of the process with the established book of charge by an independent certifying agency. This may be an initial audit on the implementation of a book of charge containing/regarding non-GMO production and so being a new cost, or it may be supplement to already existing systems (extra cost). The certificate is issued after a successful audit. A follow-up audit is required to maintain the certification status. Audit cost could however be integrated in the certification cost (see Certification).

Certification: The certification of a system is company specific. It is based on a handbook (book of charge), established by the company and, if wanted, with the aid of specific certifying agencies or organisations. The book of charge describes all relevant details such as procedures to be implemented and maintained in order to meet the agreed upon criteria. Costs are therefore related to the establishment of this book of charge (personnel, consultation) and the eventual certification of the process, after an audit has taken place.

Flushing/Cleaning: to prevent cross-contamination of non-GM products with previously produced or used conventional batches, the production line needs to be flushed with non-GM material, which can not be commercialised afterwards as non-GM. Therefore, the cost of flushing is related to the volume of the flush and the value loss of the batch.

Harvest: the machine used in the harvest has a temporal specialization

Labelling: regards the extra cost for the labelling and packaging of products.

Logistics: Some strategies might involve additional logistic costs.

Loss in flexibility: the use of GM and non-GM material at the same production site reduces the production flexibility. The number of end products increases, which means smaller batches and interruption of the production for flushing. In other cases, the transport of goods which is done by bulk transport needs to be changed to transport by smaller containers.

Monitoring: An administrative system (procedure) needs to be established and maintained. Furthermore, the monitoring costs include costs for internal and external controls. The company will establish a control system for internal controls, and the system will be certified, including certification and auditing costs (see Audit).

Operation of quality systems: relates to the extra cost needed to update the quality system.

Personnel: the introduction of GMOs in a company might require training of quality managers and technical staff. This could be part of a general information session on quality (low extra cost) or a specific GMO related training (higher extra cost). Maybe additional time is also needed after implementing the systems to handle the systems or for testing

Raw materials: the price of raw materials might increase, resulting in an increased cost of the final product.

Sampling: the introduction of GMO may lead to new or adjusted sampling procedures, more sampling, etc. This sampling however does not necessarily result in a subsequent analysis.

Segregation: the costs for segregation includes all costs to separate two batches. This could be obtained through the use of a dedicated location (e.g. storage) or of dedicated equipment (e.g. transportation line). This is a once-only cost, an investment due to the new production (see Storage and Transport respectively). Next to this, some continuous costs are also related to the segregation of GM and non-GM: cleaning and flushing of equipment (see Flushing/cleaning) and installation of a specific planning of the intake (see Loss in flexibility).

Sowing: the machine used in the sowing has a temporal specialization. Therefore, the cleaning is considered as an incremental cost.

Storage / elevator: dedicated silos for non-GM material needs to be available. There could be silos for extra intake or for storage of the end products.

Transport (internal): the transportation of materials from silo to production site or from production line to end storage might necessitate the investment in an extra transportation line.

Transport (external, e.g. trucks, ship): the transportation can be dedicated (see Loss in flexibility), or the system can be cleaned after every use (see Flushing/Cleaning).

Loading: container (bulk carrier is cheaper than container).

Weed Control: herbicide and chemical application (the herbicide in the GMO production is cheaper).

Annex 2

Draft document

1 The costs and benefits related to segregation and traceability of wheat (Denmark)

In Denmark, the majority of domestically grown wheat is utilised for feed in the pig producing industry. 80% of the domestically grown wheat is used for feed and approximately 5-10 % is used for bread production. The remaining part is exported or used in other food products such as soups and biscuits. The fairly small production of bread wheat is due to the climate conditions and restrictions related to the application of nitrogen fertilizers.

The total production of wheat in Denmark over the last 10 years is presented in figure 1.

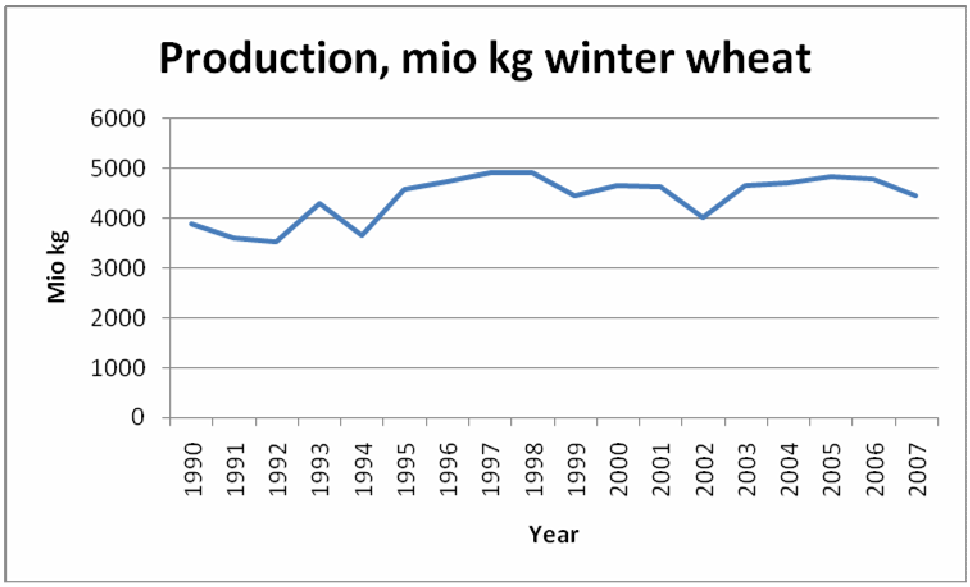


Figure 1. The production of wheat in Denmark from 1990 to 2007. (Source; Danmarks Statistik, 2007)

As can be seen the domestic production of wheat has been fairly stable over the decade and the variations has mainly been due to variations in yield.

The wheat grown for feed is stored either at the farm or at the elevators that are distributed across the country. The benefits of having own storage capacity is money saved on elevator storage and fewer costs associated with transportation. By having own storage capacity the farmer can also benefit economically from the flexibility. When prices are low stocks can be filled and utilized across the year in case of pig production, alternatively he can sell his wheat when prices are high. This however also involves a risk if there is a general decrease in prices. If the farmer sells his wheat right after harvest he does not need to invest in storage and drying capacity and he holds no responsibility of the correct handling of the wheat. Buyers of special qualities (like bread quality

wheat) demand that farmers have their own drying and storage facilities. In this way the testing of the wheat quality is performed on the farm prior to delivery at the mills. This gives the mills a chance to plan their production ahead and calling in the exact quality they need at any given time. If GM wheat is introduced the testing will have to be expanded to include an analysis for content of GM material. The fact that bread quality wheat never enters the central elevators makes segregation much simpler.

Farm supply company structure

Over the last 20 years the number of farm supply companies has decreased significantly. The tendency is towards fewer and bigger companies (Konkurrencestyrelsen, rapport 2002). The same tendency is observed for the primary producers with bigger farms producing more output pr. unit.

The market for wheat

The price for wheat depends as for all other commodities on supply and demand. In Denmark the yield and price is highly dependent on the weather which also influences the quality and hence final use of the wheat. In years with excessive rain the wheat can only be utilised as feed and the price premium of bread quality wheat cannot be obtained. In figure 2 the farmers selling price for wheat is presented.

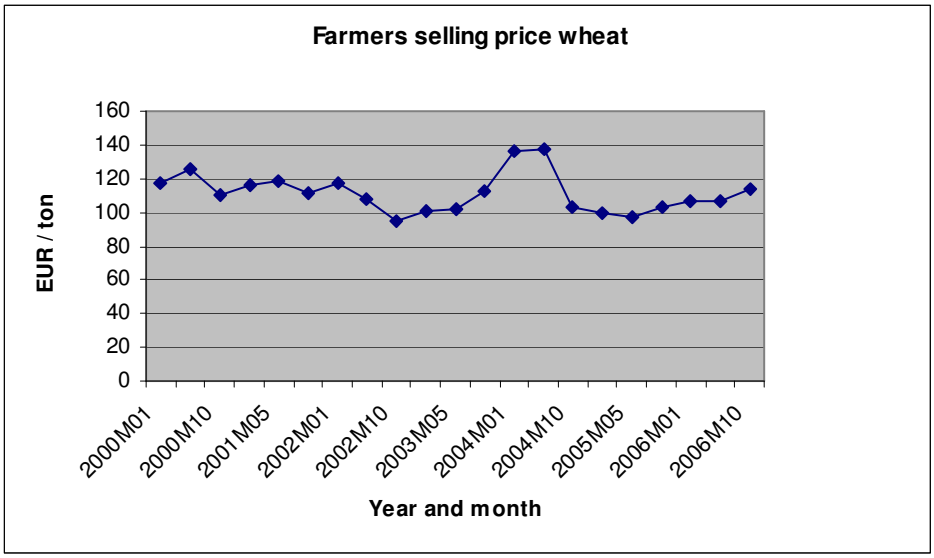


Figure 2: Farmers selling price for wheat from 2000 to 2006. (M refers to month) (Source Danmarks statistic 2007b)

The farmers selling price fluctuate over the year and on average he can gain or loose about 10% of the price dependent on when he sells his wheat. No official statistic exists on the prices for domestic produced wheat in bread quality. The price development for bread wheat is roughly the same as for wheat used for feed but bread quality receives a price premium about 10% compared to feed quality.

The demand for wheat for feed has increased substantially which is linked to the production of pigs that has increased over the last 25 year. From the beginning of the 80´s up till now the production of pigs has increased with more than 50%. This increase has led to a higher demand for wheat for feed. The increase in pig production has let to an increase in the number of farmers who stores and processes the wheat on their own farm which reduces the use of elevators. In 2001 approximately

2% of the farmers who grow wheat had their own complete storing and feed mixing facilities. This reduces the costs of transport and profit to middlemen which is a benefit for the farmer. The tendency towards storage on own farms is to a certain extent counterbalanced by an increasing demand for wheat on the big farms. Farmers specialised in pig production usually needs more wheat than they can grow on their own farm. This increases the demand for the elevator services. In total about 50% of the pigs in Denmark are fed with feed from the farmers own mixing facility (Konkurrencestyrelsen, rapport 2002).

Local market

The competition on the feed market is highly regional in Denmark. The farmers' supply of feeding stuff and feed is usually limited to nearby supply companies which on average are located within 60 km of the farmer (Konkurrencestyrelsen, rapport 2002). The main reason for the regional markets is the high costs of transporting feed over long distances. However based on a survey, local advice and service is also highly valuated and contribute to the local character of the market (Konkurrencestyrelsen, rapport 2002). In Denmark there is only one company, DLG that operates in all regions of the country. The rest of the farm supply companies that deals with feed operate in local regions.

In Denmark there are geographical differences in the production and utilization of wheat and other farm products. This influences the regional price of the wheat. The majority of farm production takes place in Jutland but there are differences related to the regional distribution between animal and crop production. In table 1 the production of cereals and animals based on regions in Denmark is presented.

Table 1 Cereal production and livestock production, based on regions in Denmark. Numbers stated in percent

	Cereals	Pigs	Poultry	Cattle
East of Great Belt (Sealand)	22.3	19.1	8.3	13.7
Funen	8.8	9.2	7.7	6.4
South Jutland	8.5	8.3	11.5	10.5
East Jutland	18.3	17.2	14.7	17.4
west Jutland	17.1	16.6	25.0	21.5
North Jutland	25.1	29.7	32.7	30.4
Total	100	100	100	100

Based on the figures in table 1 it can be observed that there are proportional more farm units with cereals compared to livestock east of the Great Belt and opposite for Jutland and Funen. This means that there is a net transport of cereals from Sealand to Funen and Jutland in order to fulfil the need of feed in Jutland and Funen. This has influence on the price development in the regions. As there is a surplus of cereals on Sealand the prices of wheat is also lower in this part of the country. In 2001 the price difference for wheat sold to the elevators was on average 10% for wheat between Jutland and Sealand. In some compound feed types wheat can constitute 85% of the feed and therefore the price of the raw material has a large influence on the cost of the final feed product. The regional price differences are therefore also reflected in the regional prices for feed.

The current selling prices for the farm supply companies for wheat for feed are roughly 129 – 132 €/ ton. The farmers selling price is currently 116 €/ ton in Jutland and Fuen and about 5.3 €/ ton less on Sealand (Landscentret, 2006). The historical price development is presented in figure 3.

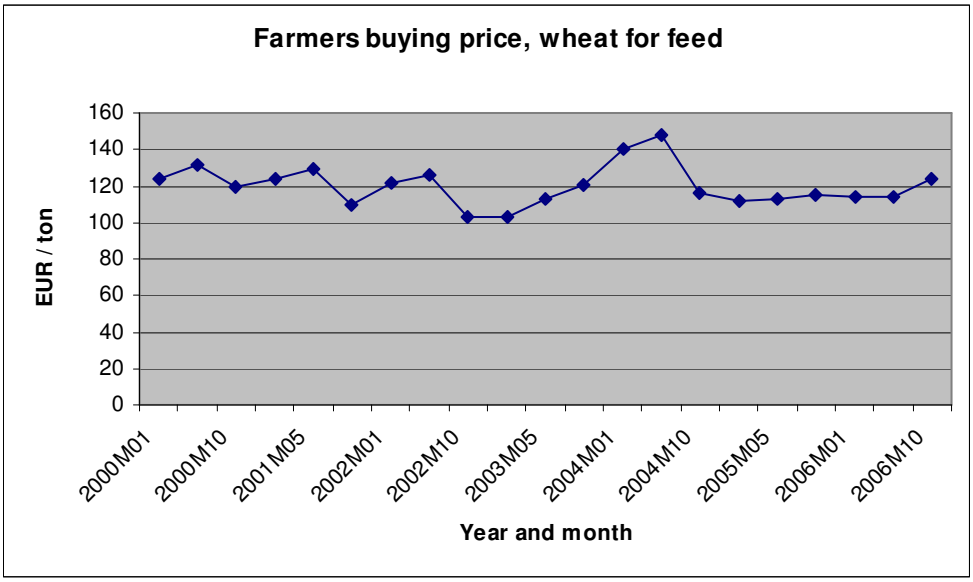


Figure 3: The price development for wheat for feed from 2000 to 2006. (M refers to month) (Source Danmarks statistic 2007c)

The prices have been fairly stable over last years.

2 Company description (flour producing mill)

The company is based in Jutland and handles food products covering primary flour for bread making and breakfast products. The company has two factories out of which only one is involved in processing of wheat to flour.

Currently the company does not handle any GM products. Some maize is imported which is stated to be GM free.

Turnover
No available data

Market share and prices
The company is one of the two major companies that operate in Denmark within the food industry related to bread. In total the company covers about 2/3 of the market share related to production of flour and cereal products sold in Denmark. Wheat flour is not a major export article as it is expensive to transport. The company exports 5,000 tons of wheat flour yearly.

60% of the flour production goes to the food industry with Schulstad Bread as the prime industry baker. 25% percent goes to the bakeries distributed across the country and the remaining 15% goes to private households.

The company is not involved in the farm production of wheat. The company has strict demands regarding quality and buys wheat from companies that can deliver the wheat at the lowest possible price. Not surprisingly DLG, which is the largest farm Supply Company in Denmark, is the main supplier of bread quality wheat. As a large part of the Danish grown bread quality wheat is traded internally on contracts that are not available to the public (DJF rapport 2001) Therefore it is not possible to obtain any statistical data regarding the price development for the Danish grown bread quality wheat. However an estimation of a 10% price premium for flour wheat is usually assumed. According to interviews the current price for bread quality wheat is about € 158 pr ton. There is no market for GM wheat yet.

Physical flow
The company handles annually 300.000 tons of cereal out of which 250.000 tons are wheat. Half of the wheat is delivered by Danish farmers. This figure has been fairly constant over the last years. The remaining 125.000 tons are primary imported from Germany and a smaller proportion from Sweden. The majority of imported wheat is transported to Denmark by ship.

The mills in Denmark are in interviews stated to be among the most modern in Europe. They are relatively new and build with segregation and traceability in mind.

3 Chosen strategy for handling coexistence

The company will supply what consumers demand. There is no current use of GM wheat and the company does not believe that there will be any in the near future. If GM crops are to be accepted by consumers there has to be some obvious benefits related to health for instance. At current the GM traits related to wheat is round-up resistance. The consumers have little faith in a commodity which trait is tolerance to a chemical that they consider harmful to the environment. In the future the company believes that there will be a market for GM, conventional and organic wheat and it is believed that there will be an extra premium for the non-GM. In the long run there will be a gradual acceptance of GM-crops.

If GM crops become a reality the strategy for the company is strictly related to one of coexistence with temporal specialisation within the same factory. The strategy is presented graphically in figure 4.

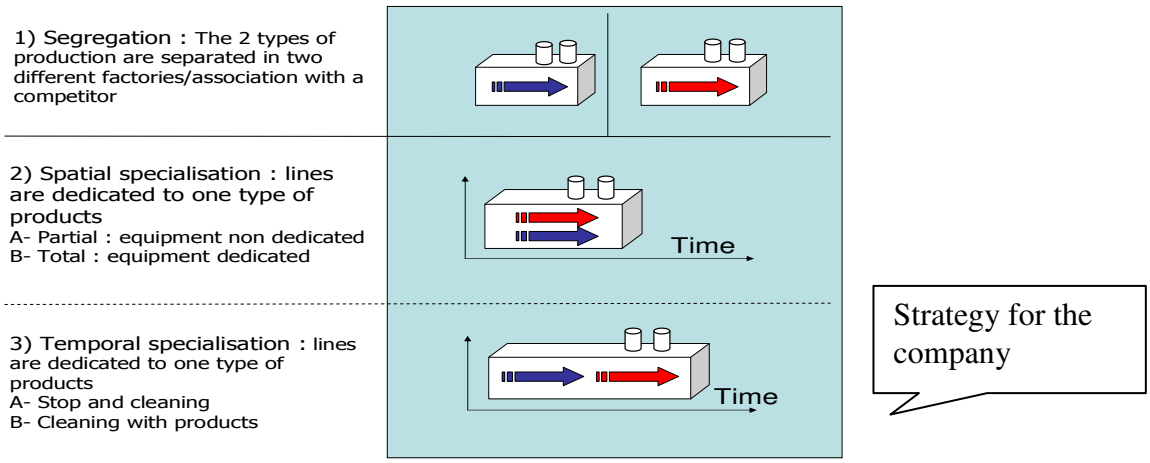


Figure 4. Strategy chosen by the firm. The strategy is regardless of the demand for GM products.

The company has no plans about investing in new separate production lines or in a new factory due to the introduction of GM wheat. The costs associated with this cannot by justified for the company. In case of fierce resistance towards GM wheat the company will only produce from non-GM wheat.

If the company had several factories it could consider having separate production lines with GM versus non-GM. This is however not relevant for the company as they only have one large mill in which they process wheat. The remaining discussion related to costs will strictly relate to a strategy with temporal segregation.

In table 2 an overview of strategy and the highest costs associated with segregation is presented. The costs and strategy is related to the GM percentage in the country.

Table 2. Strategy and the highest costs associated with segregation. The costs and strategy is related to the GM percentage.

Situation/ Change	Current	Hypothetical	Hypothetical	Hypothetical
GMO pressure[2]	100 % non-GMO	90% non-GMO	50% non-GMO	10% non-GMO
Strategy	-Temporal specialisation	-Temporal specialisation -Specific contracts with elevator -If percentage of GM lower production is not profitable	-Temporal specialisation -Specific contracts with elevator	-Temporal specialisation -Specific contracts with elevator -If percentage non-GM becomes lower production is not profitable
Highest extra costs for GM segregation		-Analysis (tests) -Possible underutilization of silo capacity -Output storage for GM bran	-Analysis (tests)	-Analysis (test) -Possible underutilization of silo capacity -Output storage for GM bran

In table 3 is shown an illustration of the physical flow of the stated scenario:

Table 3: presenting the physical flows of the assumptions

	90% non-GMO	50% non-GMO	10 % non-GMO
GM	25.000 tons	125.000 tons	225.000 tons
Non-GM	225.000 tons	125.000 tons	25.000 tons

4 Extra costs specified by activity

Administration / Registration

The company has a long experience in registration and traceability. This is crucial when dealing with many sorts of cereals in different qualities. The company has a share of organic flour production and for many years the company has been supplying the bread industry with flour based on wheat grown without growth regulators. This system is based on verifications of documents as well as physical testing.

This system can be applied to the handling of GM or non-GM wheat as well and will not result in extra costs. There will however be increased costs associated with testing for GM content. The company sees no major problem related to this aspect. They believe that the main problems related to coexistence will occur for the farm supply companies and for the international traders who are

[2] GMO pressure is the market demand for GMO/non-GMO

responsible for the international transport of wheat. It was mentioned that some of the most severe problems that have occurred related to admixture has been during transport with ships.

Analysis
The company conducts test of every truckload and every shipload. Each test is vacuum-packed and stored for five years for traceability. Analysis is believed to be a central extra cost related to co-existence. How high the costs will be depends on what kinds of tests are needed and how many tests that are needed throughout the production line. The amount of testing is also dependent on the scenario for GM wheat. If the majority of the wheat is GM, then it will only be necessary to conduct tests on the small portion of non-GM wheat. This is however at current not viewed as a likely scenario. The company believes that the most reasonable scenario is one in which GM or non-GM is produced by farmers on contracts. This system is equivalent to the procedure for the wheat they receive grown without growth regulators. With the wheat that is grown without growth regulators the company controls documents. Thereafter testing is only conducted on the final flour to see if growth regulated wheat has contaminated the flour. The same system can be applied to the GM wheat. The company expect that it will be sufficient to test batches of flour for every 10,000 tons produced with a PCR[3] test. In case there is significant resistance against GM wheat the company might conduct tests earlier in the internal supply chain, on smaller batch sizes or choose not to produce flour from GM wheat. As stated by the company "There is no intentions of being on the front page of the tabloid papers for accidentally admixing GM wheat".

The testing intensity and hence the final price of handling the wheat separately also depends on traits to be tested for. If several tests are needed to ensure that no GM material is present then cost of segregation will eventually rise. This is the case with maize where several tests are needed. In other words the cost of testing rises when the number of traits that has to be tested for increase.

According to the interview, input testing of wheat will have to be conducted in order to make sure that non-GM wheat is not contaminated. An input test, like the PCR test, is conducted for every 1.000 tons of non-GM which is assumed sufficient if the non-GM is produced on contracts. In table 4 the costs are illustrated with different shares of GM production (10-90 %).

Table 4. Proposed test intensity and cost of testing pr ton of input.

Scenario	10 % GM	50% GM	90% GM
Total amount to be tested	225.000 non-GM	125.000 non-GM	25.000 non-GM
Test-intensity	1000 tons	1000 tons	1000 tons
Total tests, amount	225	125	25
Cost per test	€140	€140	€140
Total costs	**€31500**	**€17315**	**€3463**

Table 4 indicates that the total cost of testing the production input is highest for the 10% GM scenario. This is due to the large amount of non-GM that has to be tested.

It will also be necessary to test the output flour. In this case it is considered that it is sufficient to run a test for every 10.000 tons of flour produced at the mill. The costs are presented in table 5.

[3] **Polymerase Chain Reaction test**

For simplicity we assumed that all wheat is milled to flour with no bi-products from the milling process.

Table 5. Proposed test intensity and cost of testing pr ton output.

Scenario	10 % GM	50% GM	90% GM
Total amount to be tested	225.000 non-GM	125.000 non-GM	25.000 non-GM
Test-intensity	10.000 tons	10.000 tons	10.000 tons
Total tests	22.5	12.5	2.5
Cost per test	€140	€140	€140
Total costs	**€3117**	**€1732**	**€346**

The total cost of testing for GM is naturally highest in the 90% scenario due to the testing of admixture in all the non-GM material. In the 90 % GM the costs of testing is low due to the small amount that has to be tested.

The milling company has not made any estimates of the costs associated with testing wheat for GM. An assumption is made that testing is done with PCR and that testing of wheat costs the same as testing for GM in soybeans. This will however, be further investigated.

Audit/certification

The company is certified according to ISO 9000 and ISO 14001 (environmental standard). These systems have an annual cost of 5300 €. They do not expect that any extra costs will occur due to the introduction of GM wheat. The company expects that in the case of declaring non-GM on products they may have to pay an additional 1979€ pr year for third-party certification. This will probably be demanded by consumers and retail companies. This amount will have a very marginal effect on the price pr. ton of wheat. This cost is independent of the actual amount of non-GM. In table 6 the cost of audit is presented.

Table 6. The cost of extra administration associated with GM introduction. The annual cost is unaffected by the total handling of GM or non-GM products.

GM percentage	Administration
10 %	€1979
50 %	€1979
90 %	€1979

Flushing and cleaning

All internal systems and silos that are in operation are expected to be self cleaning. By letting the conveyer belts inside run idle they can keep admixture to an acceptable level. In the case of GM this means below an admixture of 0.9 %.When shifting from for instance conventional production to organic production the mill and conveyer belt is flushed through with the organic material. The costs of doing this procedure are related to the down classification of the commodity which has been used for flushing. The flushing material has to be sold at a lower price.

To minimize these costs, the production campaigns with the various commodities are maximised. The overall cost of this procedure is hard to estimate as the lengths of the campaigns differ. The overall costs are however considered to be minimal. The same procedure as used for the

conventional / organic shift can be used for GM / non-GM and is not considered to create any problems.

The flushing costs is estimated to be 22,427 EUR pr year for all scenarios. This is based on the cost of flushing, number of flushing and the down classification of the material used for flushing. There are no extra costs associated with the 50% scenario as batch sizes are expected to be larger.

Labelling
In the factory the company is handling various types of flour that all have to be labelled differently. The company expects no extra costs associated with labelling of GM.

Loss in flexibility
When producing bread the input raw material is segregated into several different types of wheat and qualities. When wheat has to be segregated further into GM or non-GM there might be a cost of utilising silo capacity in a sub-optimal way. The actual cost of this loss in flexibility is difficult to assess. If there is adequate capacity in the silos then the costs are considered minimal or zero. However, this is not the case for the company. The actual cost of this depends on the proportion of GM / non-GM that is handled. Since flour mills are already handling different qualities and the cost of a few more qualities (non-GM and GM) are limited it is not likely to be the most expensive action when handling GM. The extra costs of testing will be the most important cost and the cost of extra storage for the wheat bran. There will also be a cost of switching production from GM to non-GM but these costs are considered to be minor compared to costs of testing.

Raw material
It is naturally difficult to estimate the cost of wheat on a hypothetical market that does not exist. From the company point of view coexistence is expected to be problematic primarily for the farm supply companies and the transporters of the commodity. Main problems are expected to occur at the elevators and on the ports where wheat is handled in large volumes. In order to insure identity preserved it is becoming more difficult to handle the grain, the price of the raw material delivered to their factory is thus likely to increase to some extend. No company estimates are made regarding the input price of GM wheat.

Transport
Domestically produced wheat arrives to the factory by lorry, whereas imported wheat is delivered by ship as lorry transport is regarded too expensive. According to the interview heavy tax burdens are placed on lorry driving in Germany and it is difficult for the drivers to get a contract with return loads to Germany. This makes transport by ship more feasible. Wheat is delivered to the company daily and distributed equally across the year. This means that there is no specific time of the year with peak production. With an even distribution across the year there is no hold ups related to tipping off loads or when testing.

The company is not directly involved in the input transport of the wheat. Their contracts are based on deliverances to the factory. Extra costs that their supplier has related to handling GM will eventually influence the companies buying price. The company specifies a given quality and conducts test at time of arrival. They are therefore not involved in the cleaning or inspection of any vehicles that transports wheat to the company. Hence they are not involved in any extra costs that might arise from extra cleaning related to input of raw material.

Company trucks are involved in the transport of flour from the mill to the factory. Lorries carrying flour from the factory to the industry are cleaned with vacuum cleaners (tank Lorries). The vacuum cleaning process takes about one hour and the cost of labour is €27.70 pr hour. Each lorry carries about 30 tons of flour. In the 10% scenario it is assumed that the truck has to be cleaned after each delivery of GM. The yearly cost of this is estimated to be €24,736. This cost is also assumed for the 50% scenario as the trucks can carry GM material for many days before cleaning. For the 90% scenario cost is also €24,736 but in this case the lorry is cleaned before any transport with non-GM. The yearly costs are presented in 7.

Table 7: The cost of cleaning trucks used for transport, after GM introduction, €

GM percentage	Output cleaning of trucks
10 %	24,736
50 %	24,498
90 %	24,736

The costs associated with cleaning of vehicles transporting flour is roughly the same. Eventually this implies scale of economies related to the transport of the wheat. For an overview of the costs pr ton see "Total cost".

Storage

It is crucial for the company that the storage capacity is utilized to its maximum. It is expensive to have silos that are only partly utilized. For this reason the company has decided not to handle any commodities in very small quantities. Therefore if the demand for either GM or for non-GM is very small they will simply not produce flour from that commodity. Interestingly when the company introduced the wheat varieties, that were grown without growth regulators, they did not need extra storage. Optimising the logistics was sufficient. The company expects that the same can be done with GM under an accidental admixture scenario with 0.9 % admixture.

If GM is introduced the company will have to separate the wheat bran in GM and non-GM and they will have to invest in more output storage capacity. At current the storage silo for wheat bran is 30 tons. This silo has to be emptied every day so in case of coexistence they will have to double the capacity. Estimates for the storage capacity are expected to be roughly €989,000. With a 10 year depreciation time this adds up to about € 98,944 pr year. In the 90% GM scenario it might not be economically sound to make that investment. Instead the non-GM bran will be sold as GM. In table 8 the yearly cost of the new storage capacity is presented. In all cases the cost is substantial and has a large influence on the total costs of segregation.

Table 8: The cost of storage for GM wheat bran.

GM percentage	Total € output storage
10 %	98,944
50 %	98,944
90 %	98,944

The costs are presented for the various scenarios. The cost of segregating non-GM wheat bran might not be feasible.

In table 9 the total cost of segregation is presented.

Table 9: Total cost of segregation based on 250.000 tons in total, stated in €.

GM percentage	10% GM	50% GM	90 GM%
Segregation			
Output storage (GM wheat bran)	98,944	98,944	98,944
Cleaning and flushing			
Cleaning trucks (output)	24,736	24,498	24,736
Traceability			
Flushing (down classification)	22,427	22,427	22,427
Input testing	31,167	17,315	3463
Output testing	3,118	1,731	346
Certification	1,978	1,978	1,978
Benefits			?
Cost raw material			?
	10%	**50%**	**90%**
Total	**182372**	**166896**	**151896**

In table 10, a theoretical distribution of costs is presented. If it is assumed that the GM or non-GM commodity share has to pay for the segregation, it can be seen that costs are high when handling small quantities. In case of 10% GM the cost will be € 7.29 pr ton for segregation GM and in case of 10% non-GM the costs comes to € 6.08 pr ton for the non-GM segregation. Costs are substantially lower when the percentage is 50% GM / non-GM. The reason for this observation is the fact that the fixed costs are distributed over a larger volume which reduces the unit costs.

Table 10. Theoretical distribution of costs of segregating GM and non-GM based on scenarios. € pr. ton.

Theoretical distribution costs pr ton		Total wheat	GM	non-GM
	10 % GM	€0.73	€7.29	€0.81
	50 % GM	€0.67	€1.34	€1.34
	90 % GM	€0.61	€0.68	€6.08

If costs of segregation is distributed to the entire volume of both non-GM and GM the cost are modest, especially in the 50% scenario. If both GM and non-GM has to be segregated in small quantities it becomes relatively expensive pr. ton output.

It is important to stress that the costs presented here do not include the price of raw material and the analysis does not take any reductions or increases in the selling price into account. The costs presented are those of keeping GM and non-GM physically separated under the current legislation with an allowed 0.9 % accidental admixture.

5 Possible benefits

According to the interview with the bread company there are currently no benefits for the bread industry related to the introduction of GM wheat. No benefits either would accrue from a better system of traceability. The entire system related to traceability is already in place according to the "Regulation (EC) No 852/2004 of the European parliament and the council of 29 April 2004 on the hygiene of foodstuffs" and "Regulation (EC) No 183/2005 of the European Parliament and of the Council of 12 January 2005 laying down requirements for feed hygiene". No new traceability systems will be set up in order to handle GM / non-GM and thus no benefits will directly arrive from increased traceability. The system that needs to be in place is one of physical segregation and testing.

Possible benefits (should the consumers in time become more friendly orientated towards GM) is related to trait that may offer special health benefits to the consumer, other qualities would be improved baking quality etc.

6 Conclusions

For the company in question no major problems are related to the handling of GM material. The company only produces at one wheat-milling factory the strategy for coexistence is therefore related to a temporal specialisation in GM-production.

In case of strong public opposition against GM-crops, implying that GM or non-GM crops has to be handled in very small quantities the company may choose not to handle small amounts in the production line..

The overall main problems of coexistence between GM and non-GM are expected to be at the farming level and during transport and storage for the elevators that supplies to the mill. The mill specifies a quality and is not involved in how the supply company lives up to the prearranged quality. Difficulties in obtaining certain qualities will naturally affect their buying price. How much depends on how the market forms.

For the company extra costs of handling and segregating GM and non-GM are primarily related to analysis and the need for output storage capacity. Secondly there may be some costs associated with storage under-utilization. The exact costs of this are not possible to estimate precisely. The cost of testing is highly dependent on consumer's acceptance and the attitude from the retailing companies. If more analysis and testing are required the price will eventually go up. The company does not however, hold any detailed information on analysis for GM material.

In table 11 and in figure 5 the company's current distribution of costs related to producing one ton of flour of non-GM is presented.

Table 11. Distribution of costs associated with producing one ton of flour

Distribution of costs	
Raw material (incl. transport)	75%
Traceability and certification	<1 %
Labour	15 %
Transport to end user (industry)	5 %
Storage	2-3 %
Analysis	< 1%
Administration	1-2 %

In figure 5, a graphical presentation of table 11 is presented.

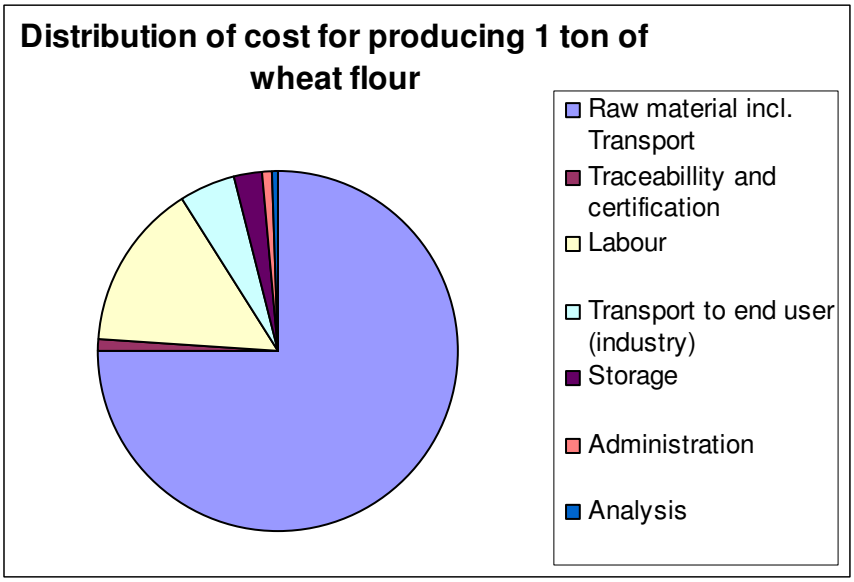


Figure 5. Distribution of costs for producing one ton of flour.

The main cost of producing flour is related to the cost of raw material, the cost of labour, cost of transport to industry, storage, traceability and certification, and finally analysis.

According to the interview with the company the main cost that will occur when GM is introduced is the cost of testing, the cost of output storage and the price of the raw material. The costs of testing can (in case of contract production) be kept to a minimum but it depends on the consumers acceptance. It is roughly estimated that when GM is introduced the costs of analysis will go from under 1% of the costs of producing flour to about 1-2 %. If the retail industry becomes very demanding regarding tests, the prices can go further up. The price of raw material is for the market to decide. Non-GM will be more expensive due to the extra handling.

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